A COMPARATIVE ANALYSIS OF MILITARY AND CIVILIAN HEALTH CARE DELIVERY SYSTEMS

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THESIS

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A Comparative Analysis
of
Military and Civilian Health Care Delivery Systems

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ABSTRACT

The present study proposes the use of the time a patient spends in a military hospital as a measure of the efficiency of that military hospital through comparison with lengths of stay in a civilian hospital. The same comparison is proposed as an indicator of how utilization patterns in the general populace may change if large-scale access to comprehensive prepaid health care is implemented. In addition an algorithm for determining the size of the population supported by a military hospital is developed.

The study concludes that length of stay can be used as a measure of hospital efficiency. However, the results of a comparison with civilian hospital lengths of stay must be tempered by consideration of the uniqueness of the military population served. It is also concluded that the probable degree of increased utilization of inpatient care resulting from large scale access to low-cost health care is very small or even negative.

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I. INTRODUCTION

In this country the belief is becoming more widely held that each and every citizen has the right to some degree of access to both preventative and curative health care. It is also increasingly accepted that the type of care received should not be significantly dependent upon one's social or economic status. As the costs of health care continue to rise, it becomes increasingly apparent that to provide this "right" the present fee-for-service system of health care delivery must be modified.

Various national and state plans to modify the present fee-for-service system are now being discussed. All of these plans call for some degree of public provision of health care. For example, on the national level there is:

1) the Health Security Act sponsored by Senator Edward Kennedy which is basically a comprehensive public approach.
2) the Health Care Insurance Act which is a tax-credit approach.
3) the National Health Insurance and Improvement Act and the Nixon Administration Partnership Act which are mixed public and private approaches.

Embodied in all of these approaches is the elimination or reduction of the present fees paid by a patient for care. To the extent that this fee acts as a rationing device, overuse of the health care system may result.

Even if overuse does not result from implementation of a low-cost health care system, utilization of present facilities should increase as more people are able to afford more extensive health care. With this increased utilization the question of the efficiency of the health care delivery system, in particular, the hospital, becomes more important. The present study examines the possible effects of large-scale access to low-cost health care using the military health care delivery system as a prototype. A method of addressing the efficiency of that prototype is also proposed.

Comparison of the length of time a patient spends in a military hospital for any specific disease or condition with the same length of stay in a civilian hospital is proposed as a measure of efficiency and of the effects of large-scale access to low-cost health care.

Comparisons done in the present study were not adjusted for population characteristics, since at present no general well-defined method to do so exists. However, in order to enable future analyses to make this adjustment, a method of determining the size and characteristics of the supported population was developed. The results from application of this methodology to the population supported by Oak Knoll Naval Hospital are presented.

II. NATURE OF THE PROBLEM

Two separate objectives were persued in this study. The first was a proposed basis for determining the specific areas into which hospital efficiency studies should be first directed. The second was the possibility of using the military health care delivery system as a prototype for a system that may develop if large-scale comprehensive access to low-cost health care were to be implemented in the United States.

A. HOSPITAL EFFECTIVENESS

At present studies underway in the area of military health care are concerning themselves with the aggragate situation. They are addressing the question of how to improve delivery of health care in the entire military health care delivery system. This approach could lead to true optimization of the system as a whole. However, implicit in this type of study is the assumption that all sub-units of the system are operating efficiently or, at least, will continue to operate as effectively as they did in the past. It is obvious that this assumption could easily be incorrect. By making decisions based on aggragate analyses that make this assumption, inefficiencies in individual hospitals would go unnoticed and, thus, uncorrected. In order to upgrade the quality of the aggragate study, but not significantly delay the desired results, a method of

quickly and accurately determining whether a hospital is operating efficiently is needed. This study proposes one method. It can be done quickly by the hospital itself on existing computing systems.

1. Hospital Efficiency

The efficiency or effectiveness of a hospital is difficult to define. Implicit in any discussion of efficiency or effectiveness of an organization is the assumption that what that organization does has been well defined, measures of how well it does the job can be made and criteria with which to compare these measures exist. However, for hospitals this has not been satisfactorily done and is a difficult task. The broad objective of a hospital is to deliver "adequate health care" to its patrons. To date no universally acceptable definition of "adequate health care" exists. Thus one is left with the task of determining how to improve efficiency or effectiveness without knowing how to define it.

No attempt is made in this study to determine a definition of "adequate health care". It is assumed that the care given a patient by a military hospital for any specific disease/condition is as adequate as that given by a civilian hospital. With this assumption the requirement to precisely define "adequate health care" is not necessary.

The present study is limited to the inpatient area of a hospital. While it is realized that this area is only a portion of the patients served by a hospital, it does occupy

the largest portion of space, personnel and time of any hospital. For this reason, it is the area to which initial efficiency studies should be directed.

2. The Hospital Unit

A hospital can be considered as a single "health care delivery unit" consisting of many elements. An element consists of a group of persons and/or an assemblage of particular equipment devoted to a specialized task in administering to a patient. Some examples of elements are: operating theaters, intensive care units, pharmacies and x-ray departments. Each of these elements operate in conjunction with others to deliver care to a patient from the time he enters the hospital until he leaves. Specific subsets of the larger set of all elements are utilized in caring for a patient with a particular disease or condition. This study proposes a method to determine which of these elements should be examined first in considering the efficiency of a hospital.

Each element of the hospital unit has a specific task assigned. Measures of effectiveness can be determined for an element itself; thus, the question of effectiveness or efficiency of an element can be addressed. Although an approach on the element level is actually a sub-optimization approach, further studies can build on this approach when trying to analyze the hospital unit. The method proposed will enable an analyst to determine which elements of a hospital unit are the best candidates for initial effectiveness

studies. The method makes comparisons with civilian hospitals through a two-stage screening process. This screening process points out those elements of the hospital unit that are the best candidates for efficiency studies at the element level. Length of stay for a particular disease or condition is the variable used in the first stage of the screening process. The seriousness of a disease/condition is the variable used for the second stage. The choice of whether to use one or two stages of the process is up to the analyst.

3. Factors Affecting Length of Stay

Among the general categories that affect the length of time a patient spends in a hospital for any particular disease/condition are the physical characteristics of the patient himself and the circumstances under which he receives care. The pertinent physical characteristics are age, sex and general physical condition. For this study, these factors are considered the same whether a patient is treated by a military or civilian hospital. The applicable circumstances under which a patient receives care are: the type of institution that treats him, the cost to the patient of the care and the seriousness of the disease/condition for which he is treated. Of these circumstances only the seriousness of the disease/condition can be considered the same for military and civilian hospitals. Seriousness of the disease/condition here is determined by the type of disease or condition the patient has. For example acute bronchitis and birth without complication are not considered

serious; whereas, acute appendicitis, diabetes mellitus and functional disease of the heart are.

Hyman Joseph [Ref. 1] in a study of 27 Iowa Hospitals found that the cost to a patient of the care he receives has little affect on the length of stay for those diseases/ conditions that are considered serious as defined above. For the less serious diseases/conditions, Joseph found that length of stay tends to go up as the cost to the patient goes down. These results have a direct impact on comparisons of lengths of stay in a civilian versus a military hospital. For those diseases/conditions considered to be serious, longer lengths of stay in military hospitals can be considered as an indication of possible inefficiencies in one or more of the hospital elements employed in the treatment of that disease or condition. This conclusion is possible since, according to Joseph, these diseases/conditions are relatively insensitive to the patient's cost. However, for the less-serious disease/condition longer lengths of stay are no indication of inefficiency, instead, they are expected because of the lower cost to the military patient.

Civilian hospitals are of two types, those who operate to make a profit for their owners and those who are funded by states or municipalities. The effect on length of stay of both these types is a tendency to lengthen it. For the profit-motivated hospital, longer lengths of stay cause added operating costs, but since they do operate for profit, the charge to the patient will exceed these costs. The result

is that longer lengths of stay produce more profit, thus, private hospitals would have the tendency to increase lengths of stay. Both types of hospitals, in general, amortize their fixed costs over patient days. This practice has the effect of also lengthening the time a patient spends in the hospital. Thus, for any specific disease or condition, if the length of stay for a military hospital is significantly longer than that for a civilian hospital, the hospital elements involved in the treatment of these diseases/ conditions are candidates for further study into their efficiency.

The most important determinant of length of stay in the hospital is the doctor. The doctor directs the treatment of and determines when a patient is ready for discharge. Given that a patient has a particular disease or condition, regardless of the type of institution, the doctor primarily determines length of stay. Thus consideration of what motivates a doctor to lengthen or shorten length of stay must be addressed if a length of stay criterion is used in analyzing a hospital.

In the civilian sector of health care almost all doctors are self-employed. Although a hospital may employ staff doctors, most doctors only use the hospitals for treatment of their patients. It is this self-employment aspect that has the greatest impact on length of stay. Under the present fee-for-service system, a doctor usually receives more money for cases that require longer lengths of stay. As long as

the marginal profitability of having a patient in the hospital is greater than zero, this self-employment aspect has the tendency to motivate a doctor to keep a patient longer than is necessary. In military hospitals this is not the case. Military doctors are paid a salary based on their rank and time in service. Regardless of how many patients treated or how long a hospital patient stays the doctor will continue to receive the same salary. Thus, there is no profit motivation for a military doctor to increase the lengths of stay for a hospital patient. In fact given the large number of persons served by a military hospital, the military doctor may be motivated instead to reduce the length of stay in order to serve more patients.

The effect of the type of institution and the doctor both have the effect, in the civilian sector, of increasing the length of stay of a patient with a given disease of condition. This bias towards longer lengths of stay suggested the screening criterion for stage I of the screening process. Stage II of the screening process then makes the final selection possible.

4. The Screening Process

To determine which elements of the hospital unit should be examined first a two-stage screening process based on disease/condition is used. The diseases/conditions to be considered are chosen on the basis of the greatest number of occurances of a specific disease/condition or on the availability of data with which to compare. Since little

data is available from the civilian sector, the diseases/ conditions chosen for this study were based on availability of comparative data.

Stage I of the screening process concerns itself with the length of stay for a particular disease or condition. For each disease/condition the mean length of stay for military patients is compared to mean length of stay for the same disease/condition in the civilian sector. Given the bias toward longer lengths of stay in the civilian sector, those military lengths of stay that are significantly longer are submitted to stage II. Those lengths of stay that are not longer are discarded.

Stage II uses the seriousness of the disease/condition as its decision variable. Of the diseases/conditions with significantly longer lengths of stay, those which are considered "serious" are retained for study with the others being discarded.

Those diseases/conditions that remain after the screening process is complete are broken into the elements that contribute to the care of the patient with that disease or condition. An efficiency study is first directed toward those elements that occur most often among the diseases/ conditions.

B. LARGE-SCALE ACCESS TO LOW-COST HEALTH CARE

It is increasingly apparent that in the United States the population at large considers access to adequate health care a right. The potentially large increase in demand for

medical services that would result from the adoption of such a principle points out that the present health care delivery system would be inadequate, as presently constructed, to handle such demand.

1. Moral Hazard

Large-scale access to comprehensive low-cost health care leads to the fear that if we guarantee access to the delivery system through government finance of care, utilization will increase to such a proportion as to deny many people any health care at all. It is felt that this increase will occur not only because more people are covered, but because people previously covered by third party insurance will, because of the lower cost to them, tend to increase their usage as well. This phenomenon of increased utilization as costs to the patient are lowered is called "moral hazard" in the insurance literature.

The question of whether moral hazard does exist is of vital importance in considering a change in the health care delivery system in the United States. If overutilization does occur government finance of care (in the form of the Kennedy Health Securities Act on a national scale) will have to take it into consideration in determining what costs should be borne by the patient and under what circumstances they should be paid.

2. The Military Prototype

Relative moral hazard is defined as the tendency for an individual to increase utilization of health care over

what he might have done under a fee-for-service plus coinsurance system. In order to best estimate the existance of relative moral hazard one should examine the utilization of an existing system in which costs to the patient are zero or minimal and access to the system is on a large-scale basis. The military health care delivery system is just such a system. As a prototype of a system that might result if large-scale comprehensive access to health care is implemented, examination of the utilization figures for the military system should enable one to determine the existance of relative moral hazard.

Military personnel and their dependents are enrollees in a prepaid comprehensive health care delivery system with no deductibles and only a nominal copayment for inpatient room charges. They are entitled to financially unlimited access to both in and outpatient medical facilities. The only rationing mechanism is the queue which forms if demand is temporarily greater than supply.

The medical personnel are likewise either military or civilian salaried employees with no economic incentive to overprescribe care.

For these reasons it is felt that careful study of the utilization patterns of military personnel can lead to a better understanding and more correct projections of the demands on medical resources attendent to implementing the general populations right to adequate health care.

The present study concerns itself with inpatient utilization patterns based on data collected from Oak Knoll Naval Hospital for the period June 1972 to May 1973. Nineteen of the 22 diseases/conditions identified by Joseph [Ref. 1] are examined. Mean length of stay for each disease/condition is calculated and compared with that realized in the fee-for-service plus coinsurance of Joseph's study.

C. POPULATION SIZE AND CHARACTERISTICS

The characteristics of the population served by a military hospital differ somewhat from that of a civilian hospital. Two characteristics are particularly different. These characteristics are age and sex.

While the mean age of all persons eligible for military health care is probably near that for the civilian community, two concentrations exist. These concentrations are in the 18-29 year old range and the 38 year old and older groups. The large number of 18-29 year olds results from the fact this age group is the age group that makes up the largest number of men presently on active duty in the military service. The 38 year old and older group results from the present retirement system. Under this system military personnel can retire after 20 years service with full rights to military health care. Although these persons do not get the same priority for health care as active duty personnel, they are,

nevertheless, entitled to it.[1] Thus, as far as a potential population to which the military hospital must serve, two concentrations of persons will exist.

In addition to the age characteristics, sex also is a key characteristic. This particular characteristic will make itself felt most predominantly in the 18-29 year old group. At present the largest majority of military personnel in this age group are male. Thus any study of military health care must concern itself with the particular medical problems of this group.

The characteristics of a population will in large part determine what type of health care must be planned for. However, the size of the entire population will largely determine how much must be offered. Unless this figure is known, little substantative planning for expansion or contraction of services can be made. In addition if meaningful comparisons are to be made between military and civilian hospitals, the size of the population served must be known. Many analytical models of health care delivery systems are based on knowledge of such facts as admission rates, surgical rates and others. Unless accurate information concerning rates is input into these models, their usefulness will be nulified. For these reasons a substantial part of the time spent in this study was spent in developing an algorithm

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[1] As presently set up active duty military personnel are assigned a priority of one. Active duty dependents are priority two and retired personnel and their dependents are priority three.

that accurately estimates the size of the population served by a military hospital. In the present study the development was keyed to the Oak Knoll Naval Hospital in Oakland, California. However, by defining the area of interest in the context of the algorithm it can be used to estimate the size of the supported population for any military hospital.

III. ANALYSIS

This analysis of the Oak Knoll Naval Hospital was conducted in four stages. The first stage consisted of development of a population-size estimating algorithm. This algorithm was then used to estimate the size of the population served by Oak Knoll Naval Hospital. The second stage of the analysis consisted of determining the age and sex characteristics of the population. The third stage of the analysis contrasted lengths of stay at Oak Knoll Naval Hospital for 19 diseases/conditions with lengths of stay at Silas B. Hays Army Hospital and 27 Iowa Hospitals.

The fourth stage consisted of an analysis of the data available on inpatients admitted to Oak Knoll from June 1972 to May 1973. This analysis included seven items. These items were:

1) admission rates per 1000 eligible personnel during the period by age and sex

2) surgical rates per 1000 eligible personnel during the period by age and sex

3) number of patient days during the period by age and sex

4) length of stay during this period by age and sex

5) admission rates per 1000 eligible personnel by age, sex and ICDA code

6) length of stay by age, sex, and ICDA code

7) length of stay by age, sex and patient category.

A. POPULATION SIZE ALGORITHM

The Naval Facilities Command [Ref. 2] proposes a method of determining the total supported population of a Navy hospital. This model was initially considered; however, it was found to be severely limited in its actual predictive value. It does not consider many factors that have a significant impact on the size of the population supported by a Naval hospital. The model specifically does not consider the following items that have a large impact on the size of the population being supported by a Naval hospital:

1) the presence of other military hospitals in the area.

2) the fact that active duty dependents can use CHAMPUS if they live greater than 30 miles from a military hospital.

3) the difference between the mean number of dependents per active duty person in the different services.

4) the number of retired personnel who have waived retired military pay or have their retirement check sent to an area outside of the area they live in.

5) a definition of the size of the area to be considered in population estimation.

For these reasons it was decided that a more complete algorithm for estimating population size was necessary.

In developing such an algorithm a two-stage approach was used. First, the different types of eligible personnel actually served during the period under consideration were

determined. Second, a method of estimating the number of these personnel actually residing in the Oak Knoll area was developed.

From reports available at Oak Knoll, it was found that eligible personnel served during the period 1 January 1972 to 31 March 1973 fell into five general categories. These categories were:

1) active duty military
2) dependents of active duty military
3) retired military
4) dependents of retired military
5) other - including reserve military and other eligible government employees.

During the period examined 99.3% of the personnel treated at Oak Knoll Naval Hospital fell into categories one through four. The algorithm was developed only to estimate the population size of each of these four categories. For this reason, the true population size will be slightly larger than that estimated by the algorithm. However, since this difference was so slight over the 15 month period examined, it was disregarded with little loss in total population size estimation.

Active duty personnel must be considered by service. This approach is necessary since available data on the size of the military population in any area is available only from the individual services. For use in the algorithm, the personnel assigned to a base were considered to be living

within a 10-20 mile radius of that base. Of the three services, Army, Air Force and Navy, only the Army and the Air Force have aggragate population sizes available for areas or bases. Army data is available as a total number of active duty personnel working in a particular county. Air Force data is available in the form of total active duty military assigned to a particular Air Force base. Navy population size must be gathered from several sources and totaled.

Data on Navy population size is available in two major forms. These forms are the number of personnel assigned to non-deploying units and the number assigned to deploying units. Both of these figures are available by Naval Base. Reference 3 contains population size by Naval installation for non-deploying units and activities. To these figures must be added the number of personnel serving in deploying units. This number is available in two forms. The first form is for deploying aircraft units and aircraft carriers. Reference 4 gives the number of personnel assigned to each aircraft squadron and aircraft carrier by homeport or homebase. The number of personnel on deploying units other than aircraft carriers is obtained by first determining which ships are homeported in the ports under consideration and adding their allowances to the figure for active duty military personnel. It was realized that this method gave a slightly inflated population size. However, the difference was considered to be insignificant.

The number of active duty dependents was calculated using service-wide Department of Defense ratios. Reference 5 contains the ratios of number of dependents per active duty military for each service. Since there is considerable difference between these ratios, the ratio for a particular service was used in estimating the number of dependents for the active duty military in that service in the area considered.

An estimate of the total number of retired military was obtained by using retirement pay check totals. The finance centers for each service were able to provide the total number of checks sent to a particular zipcode area. These totals were then added for the pertinent areas to obtain a base figure for total military residing in the area. This base figure was adjusted upward by two factors. These factors were the number of retired personnel who have their retirement checks mailed to an area different from that in which they live and the number who have waived retired pay, thus receiving no check. An estimate of the proportion of retired personnel in each of the above categories was made. This estimate was based on a survey conducted at the three Navy Exchanges serving the Oak Knoll area. Appendix A gives the sample size and confidence interval calculations for these proportions.

The number of retired military dependents living in the area was estimated by use of a ratio of dependents per retired

military obtained from the Navy Exchange survey mentioned above. Appendix A gives the sample size and confidence interval calculations for this ratio.

B. POPULATION CHARACTERISTICS

The age and sex distribution for active duty and retired military was obtained through two channels. The age and sex distribution of active duty personnel was from Department of Defense figures for the entire military population. These figures were correct as of 30 June 1972. Although the period under consideration was later than this, it was not felt that the proportions of persons falling in any age group would change significantly from the June figures. The effects of the all voluntary force on this distribution is not known. For the purpose of this study the age distribution of active duty military wives was considered the same as that of the husband.

To estimate the age and sex distribution of retired personnel survey techniques were used. Sample data obtained from the Navy Exchange survey previously mentioned were used to estimate the proportion of retired personnel and dependents falling in a certain age group and the proportion of male and female retirees.

In order to estimate the age distribution of retired personnel one must first estimate the population size and, then, through sampling, the proportion of personnel falling into a particular age group. With these two numbers it is possible to estimate the age distribution of retired personnel.

Estimating the proportions of persons falling into a particular age group is the same as estimating the probabilities that any one individual will fall into any particular group. Let $p_1, p_2, \ldots, p_m$ be the probabilities that an individual falls into each of the groups and N_j be the number from a sample of size n ($n = \sum_{j=1}^{m} N_j$) that fall in category j. The maximum likelihood estimators of the probabilities p_j are:

$$p_j = \frac{N_j}{n} \qquad j = 1,2,3,\ldots,m$$

Asymptotically ($n \to \infty$) the random vector $p = (p_1, p_2, \ldots, p_m)$ has a nonsingular multivariate normal distribution. Miller [Ref. 6] gives the results for simultaneous confidence intervals on each of the p_j. In reference to Goodman's (1965) work, he states that the Bonferroni confidence intervals are

$$p_j \varepsilon \; \frac{X_1^2(\alpha/m) + 2N_j \pm \sqrt{X_1^2(\alpha/m)[X_1^2(\alpha/m) + 4N_j(n-N_j)/n]}}{2(n + X_1^2(\alpha/m))}$$

for j = 1,2,...,m groups and are a $100(1 - \alpha)\%$ confidence region for each p_j. This interval was used to calculate the confidence intervals on the proportions obtained from the Exchange survey.

C. POPULATION AREAS

Three areas were considered in calculating the population size by use of the previously discussed algorithm. The choice of the areas was based on several considerations that potential Oak Knoll users might take into account.

Population area one (figure 1) was defined by the following boundaries: the west coast of California; the California-Nevada state line; the California-Oregon state line; and a straight line through the following points: Harmony, San Miguel, Hollister, Los Banos, Chowchilla, Sing Peak, Triple Divide and Brodie. Although population area one (figure 1) is clearly not an area in which all potential users would normally choose Oak Knoll, it is included to provide a general picture of the magnitude of the potential military health care load in the Northern California area.

Population area two (figure 2) was defined by using the first three digits of the Postal Service assigned zipcodes. These zipcodes were: 940, 941, 943, 944, 945, 946, 947, 948, 949, 950, 951, 952, 953, 956, 957, 958, 960. It was chosen because it seems to be an area in which recipients could easily use Oak Knoll if they desired. The distances to Oak Knoll from any point in the area are not so great as to preclude a one day visit. However, the user does have a choice of three major military hospitals in the area (Travis, Letterman and Oak Knoll.) In addition much of the area lies outside a 30-mile radius placed around each hospital, thus CHAMPUS is a possible alternative. Area two, then, is of more interest than area one, but area three is the area that Oak Knoll would serve almost exclusively.

Area three (figure 3) consisted of the California counties Alameda, Contra Costa, Santa Cruz, Santa Clara and

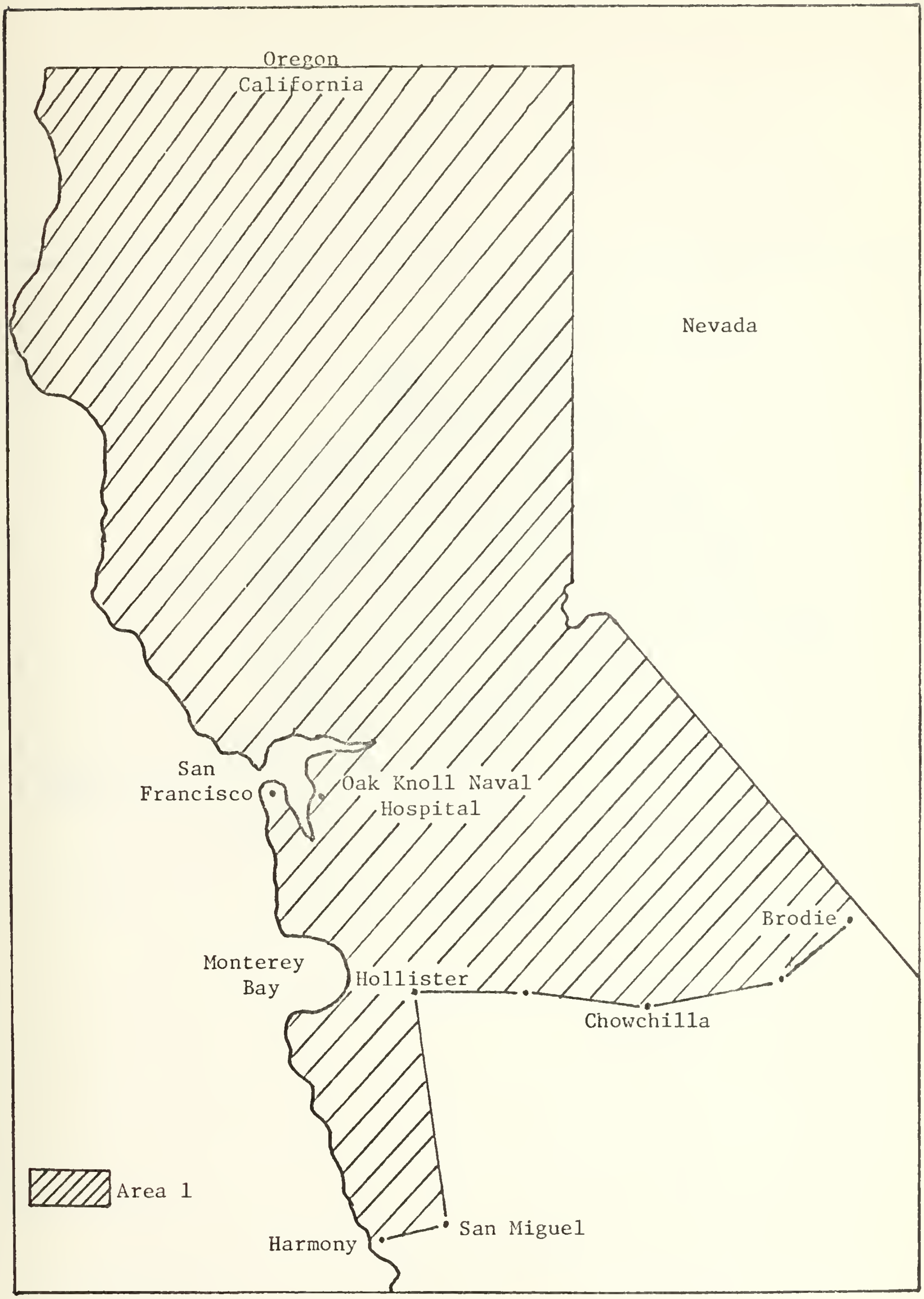

Figure 1 Population Area 1

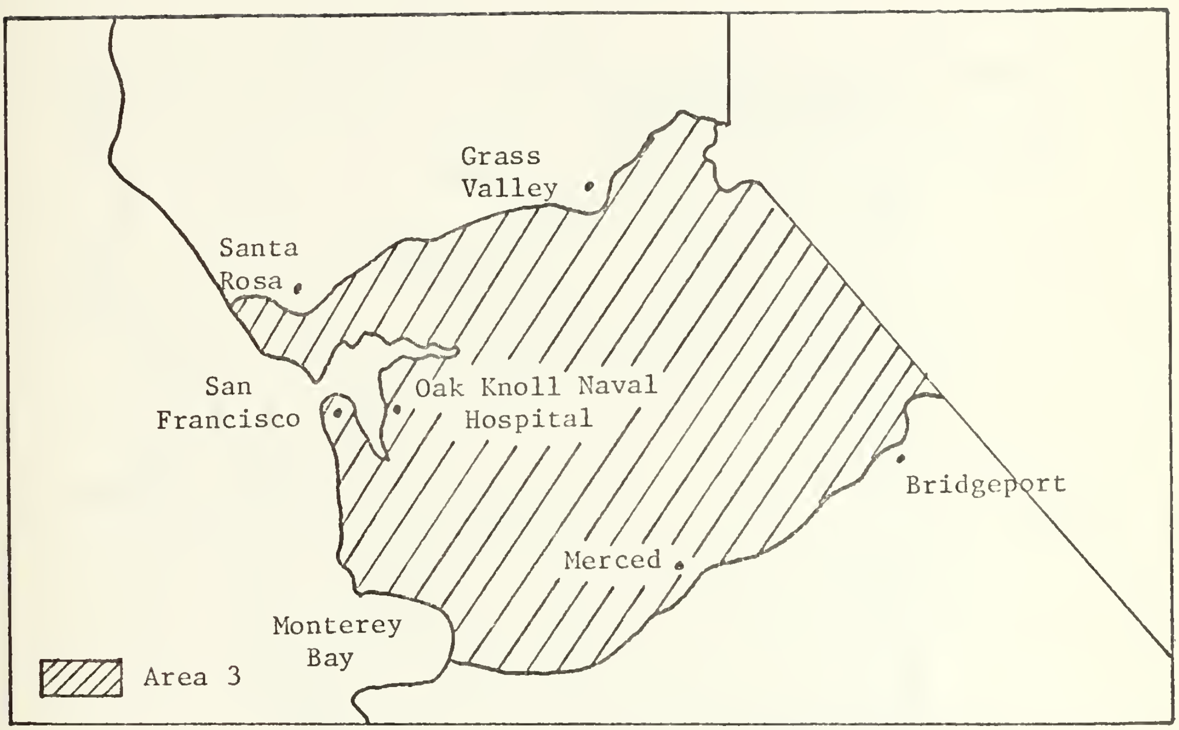

Figure 2 Population Area 2

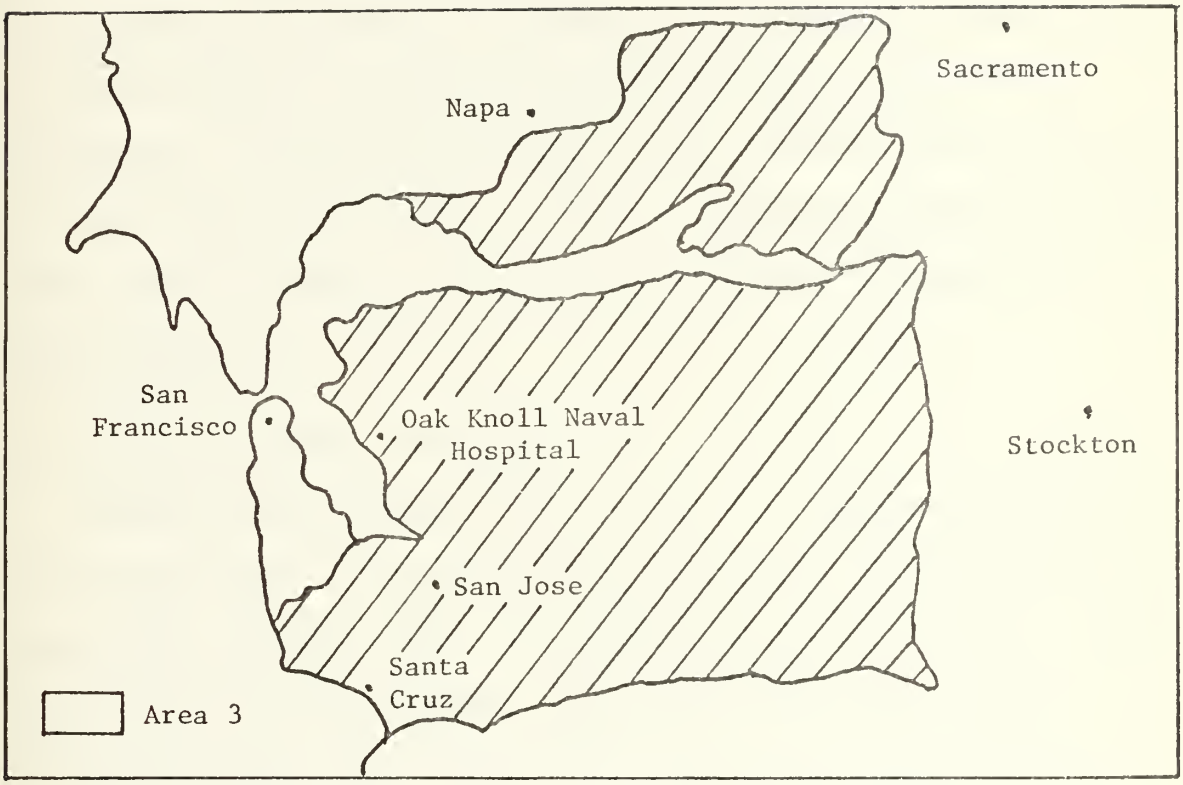

Figure 3 Population Area 3

Sanoma. It was chosen for two reasons. First it seemed to be the area in which potential users would logically choose Oak Knoll over the other two hospitals. This appearance is based solely on direct access to the hospital. From any point in the area, a user has less than a one-hour trip to the hospital. San Francisco, San Mateo and Marin counties were eliminated from this area since it was felt that using a "direct-access" criterion potential users would use Letterman. In addition to the direct access criterion, most of area three lies within a 30-mile radius of Oak Knoll and, thus, use of CHAMPUS by active duty military dependents is not permitted.

D. LENGTH OF STAY COMPARISON

Comparison of length of stay for 19 diseases/conditions for inpatients at Oak Knoll Naval Hospital was conducted in two stages. Walsh [Ref. 7] obtained data for Silas B. Hays Army Hospital and compared this data with those collected by Hyman Joseph [Ref. 1] for 27 hospitals in the state of Iowa. In the two stage comparison conducted in this study, length of stay at Oak Knoll Naval Hospital is compared to the Silas B. Hays Army Hospital data and the Iowa data.

Two criterion were placed on the data gathered at Oak Knoll Naval Hospital. First the length of stay is only for the time the patient actually spent in the Navy hospital. The time a patient spent at other hospitals prior to being transferred to Oak Knoll is not included. Second in the system used at Oak Knoll, more than one diagnosis is

possible for any one patient. For this study, the diagnosis considered as the main or primary diagnosis was the one to which a particular patient's length of stay was accredited.

Comparison of the three sets of data took the form of hypothesis testing. Let μ_i^O be the mean length of hospital stay for disease/condition i at Oak Knoll Naval Hospital, with μ_i^H and μ_i^I the corresponding mean length of stay for Silas B. Hays and the Iowa Hospitals, respectively. The two hypotheses to be tested are:

1) that patients with observed "disease" i admitted to Oak Knoll Naval Hospital actually stayed no longer than those admitted for the same condition at Silas B. Hays Army Hospital. That is:

$$H_1: \quad \mu_i^O \leq \mu_i^H \qquad \text{for some given i}$$

2) that patients with observed "disease" i admitted to Oak Knoll Naval Hospital actually stayed no longer than those admitted for the same condition at Iowa Hospitals. That is:

$$H_1: \quad \mu_i^O \leq \mu_i^I \qquad \text{for some given i.}$$

The following notation is used:

$\overline{X}_{Oi}$ = sample mean length of stay for disease i at Oak Knoll Naval Hospital

N_{Oi} = sample size of patients for disease i at Oak Knoll Naval Hospital

S^2_{Oi} = sample variance of length of stay for disease i at Oak Knoll Naval Hospital

$\overline{X}_{Hi}$ = sample mean length of stay for disease i at Silas B. Hays Army Hospital

N_{Hi} = sample size of patients for disease i at Silas B. Hayes Army Hospital

S^2_{Hi} = sample variance of length of stay for disease i at Silas B. Hays Army Hospital

$\overline{X}_{Ii}$ = sample mean length of hospital stay for disease i on Iowa Hospitals

N_{Ii} = sample size of patients for disease i in Iowa Hospitals

S^2_{Ii} = sample variance of length of stay for disease i in Iowa Hospitals

A t test, using pooled variance, was used to compare the mean lengths of stay. Data from Oak Knoll Naval Hospital was compared to data from Silas B. Hays Army Hospital and the 27 Iowa Hospitals. The following test statistics were used:

For the Oak Knoll and Hays comparison:

$$t_i = \frac{\overline{X}_{Hi} - \overline{X}_{Oi}}{S_p\sqrt{\frac{1}{N_{Hi}} + \frac{1}{N_{Oi}}}}$$

where:

$$S_p = \frac{(N_{Oi}-1)S^2_{Oi}+(N_{Ii}-1)S^2_{Ii}}{(N_{Ii}+N_{Oi}-2)}$$

represents the pooled variance. t_i was assumed to have a t distribution with $(N_{Hi}+N_{Oi}-2)$ and $(N_{Ii}+N_{Oi}-2)$ degrees of freedom for the Oak Knoll and Hays comparison and the Oak Knoll and Iowa comparison, respectively. The probability of rejecting the null hypothesis if it were true was chosen to be 0.01. The null hypothesis was rejected if $t_i < t_{.01}$.

IV. RESULTS AND CONCLUSIONS

The results of this study and the conclusions therefrom are divided into five sections: population size, population characteristics, the screening process, relative moral hazard, utilization patterns and other statistics and rates. The population size section presents the results from the population size estimating algorithm. The population characteristics section discusses the age and sex distribution of the two largest elements of the population served by Oak Knoll Naval Hospital. The disease screening section discusses the results of the efficiency screening process applied to 19 diseases/conditions. The relative moral hazard section addresses the conclusion reached on the existance of relative moral hazard resulting from considering the military hospital as a prototype for a system providing large-scale access to low-cost health care. The general utilization patterns section discusses two observations on utilization discovered during this study. The final section presents some basic statistics for the Oak Knoll Naval Hospital that will be of use in future efforts to age and sex adjust utilization data presented in this and future studies. All results and conclusions involving population size or composition are based on the estimated population in Population Area 3.

A. POPULATION SIZE

Table I gives the population size resulting from the estimating algorithm. Since the size of any population varies with time, this algorithm is highly time dependent. However, precluding any massive military buildup or cutback, the algorithm does produce an estimate that is good over the short run.

Table II lists those parameters used in estimating the mean number of dependents for active duty and retired military personnel, the proportion of retireds who bank outside of the population areas considered and the proportion of retired personnel who have waived military retired pay. The mean number of dependents for active duty personnel was determined from Department of Defense figures in Ref. 5. The mean number of dependents for retired personnel, the proportion who waive military retired pay and the proportion who bank outside the pertinent population areas were determined from the Navy Exchange Survey.

For this algorithm and for the time frame considered (30 June 1972 - 30 May 1973) four factors were not taken into account. The first factor was the number of persons eligible for health care in government sectors other than those listed in Table I. For example, Coast Guard personnel are not included. These sectors made up only 0.7% of the users of Oak Knoll Naval Hospital during the period 1 January 1972 to 31 March 1973. Because of this minute utilization of Oak Knoll by these groups, they were not

TABLE I

POPULATION SIZE ESTIMATES

CATEGORY	POPULATION AREAS 1	2	3
ACTIVE DUTY			
PERSONNEL			
ARMY	16,059	5,744	5,069
AIR FORCE	29,700	18,600	0
NAVY	37,576	35,370	31,269
DEPENDENTS			
ARMY	31,656	11,315	9,986
AIR FORCE	59,400	37,200	0
NAVY	63,879	60,129	54,697
RETIRED			
PERSONNEL			
BASE NUMBER[1]	57,843	55,333	26,501
ADJUSTMENT[2]	6,305	6,085	2,888
DEPENDENTS	122,792	118,523	56,257
TOTALS	425,210	348,799	186,667

NOTES:

1. THIS NUMBER IS BASED ON THE NUMBER OF RETIRED-PAY CHECKS SENT TO AN AREA AS OF DECEMBER 1972.

2. THIS NUMBER IS THE SUM OF THE NUMBERS OF RETIRED PERSONNEL WHO HAVE WAIVED RETIRED PAY OR HAVE THEIR RETIRED-PAY CHECK SENT TO A BANK OUTSIDE THE POPULATION AREAS.

TABLE II

POPULATION SIZE ESTIMATING PARAMETERS

MEAN NUMBER OF DEPENDENTS PER MEMBER:

ARMY:	1.9
AIR FORCE:	2.0
MARINE CORPS:	1.5
NAVY:	1.7
RETIRED, ALL SERVICES:	1.9

PROPORTION OF RETIRED PERSONNEL WHO BANK OUTSIDE OF THE AREAS CONSIDERED:	0.078
PROPORTION OF RETIRED PERSONNEL WHO HAVE WAIVED RETIRED MILITARY PAY:	0.031

considered in the algorithm even though they are a part of the supported population and, thus, potential users. The second factor was the rate of growth of the retired population. For this study retired persons were counted as of December 1972. Based on Air Force figures, the retired community increases at the rate of 0.5% a month. Consideration of this rate of growth is necessary for projections of future retired community sizes; however, for the present study this factor was not considered large enough to significantly affect results. The third factor was the difference between actual numbers of persons assigned to a Navy ship and the published allowances. In general, the actual number on board is usually less than 10% lower than the allowance. For the areas considered in this study, personnel on ships accounted for approximately 7% of the total population size; thus, the difference between the actual number of assigned personnel and the allowance has little effect on the total population size. The final factor not considered was the proportion of retired personnel who bank in the population areas considered, but live outside of them. No effective means of measuring this proportion, outside of a survey of all military retirees, exists. For this reason the factor was not considered.

The four factors mentioned above would have various effects on the population size that would result from their inclusion in the algorithm. By not considering the number of eligibles in other sectors and the rate of growth of the

retired population, the algorithm underestimates the population size. However, by not considering ship allowance versus actual assigned personnel and the number of retirees who live away from the area that have their checks sent to banks in the areas considered, the algorithm overestimates the population size. It is obvious that the four factors will tend to cancel each other. However, the extent to which the four factors completely nullify the effects of each other is not known.

B. POPULATION CHARACTERISTICS

Two characteristics of the population served by Oak Knoll Naval Hospital were determined. These characteristics were age and sex. The age characteristics determined were the age distribution of active and retired military personnel. The proportion of males and females in the active duty and retired military personnel communities was also determined.

Figure 4 gives the estimated age distribution of active duty male personnel in population area three as of 30 June 1972. This distribution was obtained by applying the proportion of personnel in each age category obtained from Ref. 5, to the estimated population size. Estimates of the proportions of females falling in each age category were not available. However, since females make up less than 5% of the present military force, it was not felt they would significantly change the age distribution. Figure 4 clearly shows the existance of a concentration of personnel in the 18-29 year old age group.

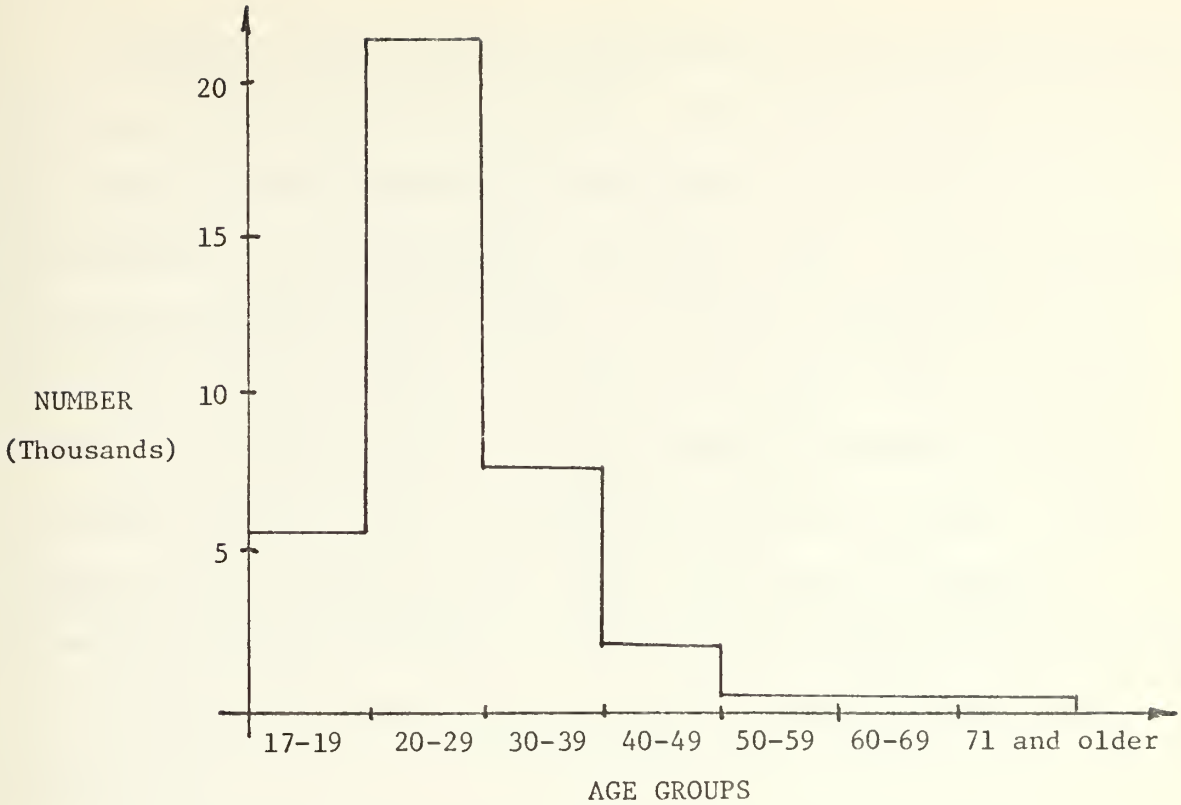

Figure 4 Estimated age distribution of active duty personnel in Population Area 3

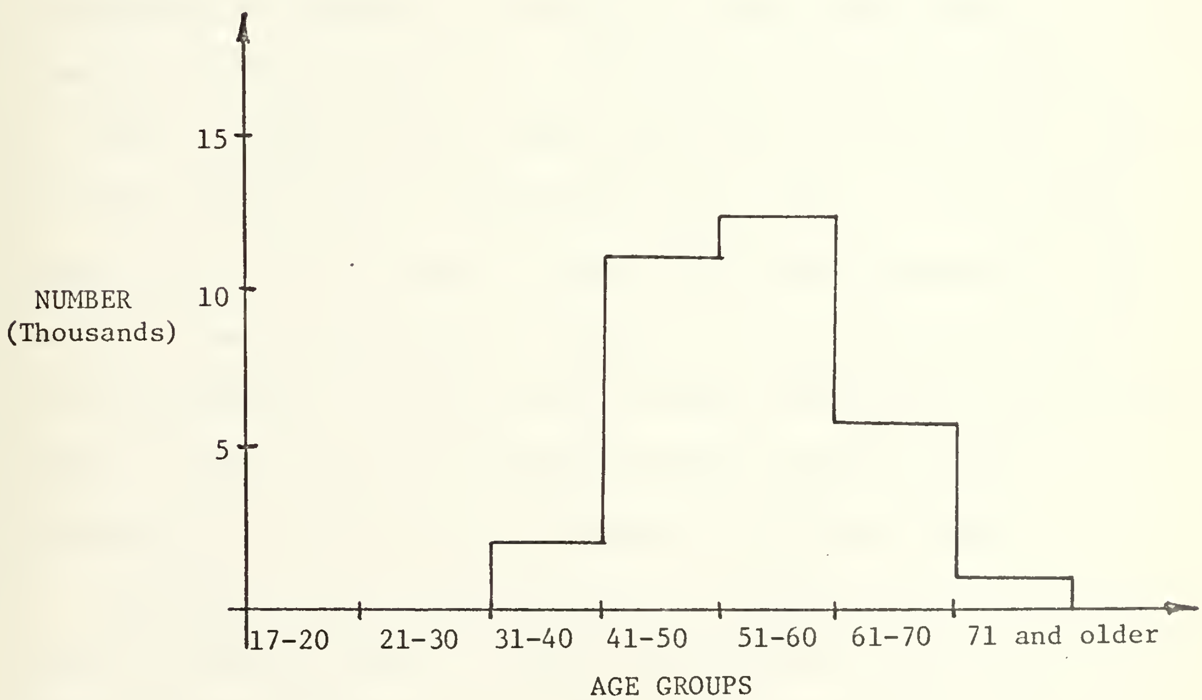

Figure 5 Estimated age distribution of retired personnel in Population Area 3

Figure 5 shows the age distribution for retired personnel living in population area three. This distribution was obtained by applying the estimated proportions of personnel in each age group to the estimated population size. These proportions were determined from a survey of retired personnel in the Oak Knoll area. Table III lists the proportions estimated from this survey and the 95% confidence interval for each. A sample size of 1242 was obtained from the survey. This sample size is smaller than that required by Appendix A. However, the main effect of this smaller sample size is simply to increase the size of the confidence interval for each proportion.

As expected the number of males in both the active duty and retired military personnel categories greatly exceeds the number of females. From Ref. 5 the proportion of females on active duty as of 30 June 1972 was determined to be 0.022. Applying this same proportion to the active duty military personnel in population area three, it was determined that 2,222 of the 101,021 active duty personnel were female. The proportion of females in the retired community was determined from the Navy Exchange survey and found to be 0.039. Thus, of the estimated 29,389 retired military personnel in population area three, 1,146 are female.

Although the above numbers do indicate that the population is largely male, it must be noted that over 98% of the male retired personnel and over 54% of the male active duty personnel are married. These two percentages add females

TABLE III

ESTIMATED PROPORTIONS AND CONFIDENCE INTERVALS
OF RETIRED PERSONNEL IN DESIGNATED AGE CATEGORIES

AGE CATEGORY	ESTIMATED PROPORTION	95% CONFIDENCE INTERVAL
31 -- 40	0.057	0.042 -- 0.153
41 -- 50	0.345	0.312 -- 0.381
51 -- 60	0.394	0.359 -- 0.431
61 -- 70	0.173	0.202 -- 0.046
71 AND OLDER	0.031	0.020 -- 0.046

to the population supported and, thus, tend to somewhat even out the distribution of males and females.

C. DISEASE SCREENING

This section discusses the results of the screening process. Table IV lists those International Classification of Disease (ICDA) codes examined in this study and the disease or condition to which they are assigned. Joseph [Ref. 1] in his study of Iowa Hospitals uses International Morbidity codes to describe the diseases/conditions examined. These two systems are not exactly the same. Specifically for this study, the International Morbidity Code for hernia of the abdominal cavity without mention of obstruction is 560, but the ICDA system assigns 550 and 553 to this condition. These two codes were combined in the analysis and appear as ICDA code 550 in all tables. The specific diseases and conditions used in this study were chosen because of the availability of comparative data (i.e. Joseph's).

Initially, comparisons were made with data collected by Walsh [Ref. 7] in his study of Silas B. Hays Army Hospital. Table V gives the results of this comparison. Of the 14 comparisons made the following diseases/conditions were found to have significantly longer lengths of stay at Oak Knoll:

Influenza, unqualified

Hypertroply of tonsils and adenoids

Displacement of intervertebel disc

TABLE IV

INTERNATIONAL CLASSIFICATION OF DISEASES CODES ADAPTED FOR USE IN THE UNITED STATES (ICDA)

ICDA CODE	DISEASE/CONDITION
0092	Gastroenteritis and colitis
250	Diabetes mellitus
427	Symptomatic heart disease
431	Cerebal hemorrhage
440	Arteriosclerosis
455	Hemorroids
466	Acute Bronchitis and bronchiolitis
470	Influenza, unqualified
485	Bronchopneumonia, unspecified
486	Pneumonia, unspecified
500	Hypertroply of tonsils and adenoids
532	Ulcer of duodenum
535	Gastritis and duodenitis
540	Acute appendicitis
550	Inguinal hernia without mention of obstruction
5749	Cholelithiasis, other and unspecified
575	Cholecystitis and cholongitis, without mention of calculus
626	Disorders of menstruation
6409	Abortion, without mention of sepsis or toxemia
725	Displacement of intervertebel disc
820	Fracture of neck of femur

TABLE V LENGTH OF STAY COMPARISON

A -- OAK KNOLL B -- SILAS B. HAYS C -- IOWA

ICDA CODE	SAMPLE SIZE			SAMPLE MEAN			SAMPLE VARIANCE			T STATISTICS	
	A	B	C	A	B	C	A	B	C	A/B	A/C
250	85	162	381	17.3	12.8	9.7	1195.8	128.4	107.4	-1.51	-3.62
427	80	43	217	11.0	7.9	9.0	282.9	96.6	164.7	-1.11	-1.10
440	21	0	968	13.8	0.0	12.2	175.8	0.0	1260.2	**	-0.20
455	68	103	240	7.5	11.7	6.8	31.4	645.8	9.9	1.34	-1.33
466	31	92	603	5.5	5.3	6.3	53.1	40.5	37.4	-0.11	0.75
470	3	39	229	9.7	3.1	5.7	104.2	16.6	33.5	-2.39	-1.17
485	5	55	338	14.2	6.3	7.9	201.4	55.6	1003.7	-2.09	-0.44
486	59	7	266	8.8	11.3	9.1	99.9	75.2	66.9	0.64	0.28
500	278	72	1357	4.1	2.3	1.7	10.4	0.4	1.2	-4.83	-22.36
532	40	38	439	22.8	13.6	8.7	608.6	120.7	56.5	-2.10	-8.45
535	33	28	428	9.9	7.3	4.4	273.8	92.4	13.4	-0.74	-5.46
540	94	19	437	9.1	17.5	6.6	56.5	82.1	27.4	4.29	-3.87
550	232	0	792	8.0	0.0	7.1	68.8	0.0	36.3	**	-1.80
5749	19	0	448	7.4	0.0	10.4	72.2	0.0	51.4	**	1.80
575	55	0	250	5.8	0.0	9.0	13.3	0.0	49.9	**	3.30
626	267	194	300	3.4	3.4	3.7	48.6	9.1	9.9	0.02	0.70
6409	10	0	359	3.8	0.0	2.7	2.8	0.0	5.9	**	-1.40
725	118	35	305	27.0	12.9	11.2	567.4	94.7	59.7	-3.41	-10.27
820	20	31	221	46.1	81.6	24.3	2153.8	5421.3	2441.1	1.92	-1.90

** DATA NOT AVAILABLE FOR SILAS B. HAYS ARMY HOSPITAL

Since the length of stay for only three diseases/conditions were found to be longer, it was concluded that for the diseases/conditions examined that there is little difference between lengths of stay at Oak Knoll Naval Hospital and Silas B. Hayes Army Hospital. Extensions of this conclusion to military hospitals in general should not be made.

The results of stage one of the efficiency screening process are also given in Table V. Comparisons of length of stay for Gastroenteristes and Colitis and Cerebal Hemorrhage were not made because of the small (n=1) sample sizes available from Oak Knoll.

Of the 19 diseases/conditions compared, the following were significant at a 0.99 level of significance. That is, the hypothesis that mean lengths of stay at Oak Knoll for the disease/condition compared are less than or equal to those for the Iowa Hospitals is rejected.

Diabetis mellitus

Hypertroply of tonsils and adenoids

Ulcer of duodenum

Gastritis and duodenitis

Accute appendicitis

Displacement of intervertebel disc

These results agree with those found by Walsh [Ref. 7] with four exceptions. Compared with the Iowa Hospitals length of stay for displacement of intervertebel disc was not found to be significantly longer for patients at Silas B. Hays Army Hospital. However, three additional diseases/conditions were

found to have significantly longer lengths of stay at Hays. These diseases/conditions were:

Hemorroids

Hernia of abdominal cavity without mention of obstruction

Fracture of neck of femur, hip

Those diseases/conditions found to have significantly longer lengths of stay at Oak Knoll were then passed on to screening stage two.

Of those diseases/conditions found to have significantly longer mean lengths of stay, the following were considered to be serious:

Diabetis mellitus

Ulcer of duodenum

Accute appendicitis

Displacement of intervertebel disc

Thus, the elements of the hospital unit which contribute to the care of patients with these diseases/conditions are those toward which initial efficiency studies should be directed. The most common element contributing to the treatment of these diseases/conditions is the operating theater. Thus, initial efficiency studies should be directed at the operation of the surgical system at Oak Knoll. However, before this type of study is undertaken two other aspects affecting length of stay should be examined.

All four of the diseases/conditions that emerge from the screening process require a determination of fitness

for duty by a medical board and some recuperative period. Before any efficiency oriented study of the surgical system at Oak Knoll is undertaken, the effects of the "medical board" and recuperative period on the diseases/conditions found to have longer lengths of stay must be quantified.

D. RELATIVE MORAL HAZARD

By considering the military hospital as a prototype for a system of large-scale access to low-coast health care, the results of comparisons of lengths of stay given in Table V can be used to give an indication of the existance of relative moral hazard. In six of the 19 cases examined, lengths of stay at Oak Knoll were significantly (statistically) longer. However, in 12 of the 19 cases, the lengths of stay were the same or shorter. Several mitigating factors must be considered before a conclusion concerning the existance or nonexistance of relative moral hazard can be made. These factors concern the characteristics of the population supported by Oak Knoll and two unique features of the military hospital.

The data from Oak Knoll Naval Hospital was not age and sex adjusted for differences between the population served by Oak Knoll and that served by the Iowa Hospitals. The two-humped age distribution of the military population is unique to military populations. The existance of a large portion of the population in the 40 to 70 year old age group should have a tendency to increase the length of stay for the population as a whole. However, examination of the data

in Table VI for the diseases/conditions which had longer lengths of stay (ICDA codes 250, 500, 532, 535, 540, and 725) shows that it is not this age group that causes the increase. The longer lengths of stay in all cases tends to occur in the under 40 year old age groups. While surprising, this result supports the conclusions that can be made from considering two unique factors affecting length of stay in a military hospital.

The previously discussed existance of "medical boards" and the lack of recuperative facilities outside the hospital both have a tendency to increase the lengths of stay for active duty personnel. The data in Table VI indicates that longer lengths of stay do occur for the larger active duty age groups. "Medical boards" tend to increase the lengths of stay for all active duty personnel; however, the lack of recuperative facilities outside the hospital is mitigated by another variable, marital status. Single active duty personnel must spend their recuperative period in the hospital, since barracks are not set up to deliver recuperative care. However, married active duty personnel can go home for their recuperative care the same as a civilian. The extent to which marital status affects lengths of stay has not been determined.

The final factor that may have caused longer lengths of stay to have resulted for the Oak Knoll data was the consideration given to diagnosis in calculating lengths of stay. The main or primary diagnosis was considered to be the only

TABLE VI

LENGTH OF STAY; BY AGE, SEX AND ICDA CODE

ICDA CODE : 0092

	MALE			FEMALE		
	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	3.0	1.8	12	3.4	6.6	5
6-20	4.8	34.0	24	3.0	2.0	13
21-30	3.8	4.7	16	4.0	9.7	7
31-40	13.0	64.0	2	1.5	0.3	2
41-50	13.3	277.7	4	2.5	0.3	2
51-60	7.0	9.0	2	15.3	150.9	3
61-70	0.0	0.0	0	0.0	0.0	0
71 AND >	5.0	0.0	1	22.5	420.3	2

ICDA CODE : 250

	MALE			FEMALE		
	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	0.0	0.0	0	6.0	0.0	1
6-20	6.0	18.0	6	10.3	42.9	6
21-30	33.8	175.8	5	5.9	12.8	11
31-40	26.6	516.1	12	7.6	26.8	7
41-50	93.6	11093.4	5	10.9	79.8	7
51-60	10.0	31.5	4	10.3	13.6	7
61-70	6.8	24.6	5	7.7	5.6	3
71 AND >	10.3	98.2	4	2.5	0.3	2

ICDA CODE : 427

	MALE			FEMALE		
	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	0.0	0.0	0	0.0	0.0	0
6-20	29.0	248.0	3	0.0	0.0	0
21-30	43.3	1092.2	6	4.0	0.0	1
31-40	24.6	362.6	5	1.3	1.6	3
41-50	3.6	5.8	9	4.8	29.2	4
51-60	5.5	81.6	13	7.7	92.6	6
61-70	8.0	176.5	8	8.7	20.5	7
71 AND >	5.9	9.0	7	8.5	20.5	8

ICDA CODE : 431

	MALE			FEMALE		
	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	0.0	0.0	0	0.0	0.0	0
6-20	0.0	0.0	0	0.0	0.0	0
21-30	0.0	0.0	0	0.0	0.0	0
31-40	0.0	0.0	0	0.0	0.0	0
41-50	0.0	0.0	0	0.0	0.0	0
51-60	0.0	0.0	0	0.0	0.0	0
61-70	0.0	0.0	0	0.0	0.0	0
71 AND >	0.0	0.0	0	5.0	0.0	1

TABLE VI (continued)

ICDA CODE : 440

	MALE			FEMALE		
	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	0.0	0.0	0	0.0	0.0	0
6-20	0.0	0.0	0	0.0	0.0	0
21-30	0.0	0.0	0	0.0	0.0	0
31-40	32.0	0.0	1	0.0	0.0	0
41-50	33.5	380.3	2	0.0	0.0	0
51-60	10.7	97.3	13	9.0	49.0	2
61-70	4.5	6.3	2	24.0	0.0	1
71 AND >	0.0	0.0	0	0.0	0.0	0

ICDA CODE : 455

	MALE			FEMALE		
	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	0.0	0.0	0	0.0	0.0	0
6-20	8.0	0.0	1	1.0	0.0	1
21-30	7.3	2.9	6	11.0	0.0	1
31-40	13.4	61.1	16	4.9	1.1	8
41-50	5.3	3.3	13	5.2	4.8	9
51-60	8.3	29.6	3	3.0	2.0	4
61-70	3.5	0.3	2	4.0	0.0	1
71 AND >	11.0	4.0	2	6.0	0.0	1

ICDA CODE : 466

	MALE			FEMALE		
	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	4.5	12.9	18	3.8	0.7	4
6-20	0.0	0.0	0	0.0	0.0	0
21-30	6.0	0.0	1	1.0	0.0	1
31-40	0.0	0.0	0	3.5	0.3	2
41-50	42.0	0.0	1	0.0	0.0	0
51-60	6.0	0.0	1	2.0	0.0	1
61-70	0.0	0.0	0	6.0	0.0	1
71 AND >	0.0	0.0	0	3.0	0.0	1

ICDA CODE : 470

	MALE			FEMALE		
	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	0.0	0.0	0	0.0	0.0	0
6-20	0.0	0.0	0	0.0	0.0	0
21-30	0.0	0.0	0	2.5	2.3	2
31-40	0.0	0.0	0	0.0	0.0	0
41-50	0.0	0.0	0	0.0	0.0	0
51-60	0.0	0.0	0	0.0	0.0	0
61-70	0.0	0.0	0	24.0	0.0	1
71 AND >	0.0	0.0	0	0.0	0.0	0

TABLE VI (continued)

ICDA CODE : 465

	MALE			FEMALE		
	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	14.8	250.2	4	0.0	0.0	0
6-20	0.0	0.0	0	0.0	0.0	0
21-30	12.0	0.0	1	0.0	0.0	0
31-40	0.0	0.0	0	0.0	0.0	0
41-50	0.0	0.0	0	0.0	0.0	0
51-60	0.0	0.0	0	0.0	0.0	0
61-70	0.0	0.0	0	0.0	0.0	0
71 AND >	0.0	0.0	0	0.0	0.0	0

ICDA CODE : 466

	MALE			FEMALE		
	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	6.4	13.6	10	4.8	3.8	11
6-20	4.7	2.5	7	4.7	3.6	3
21-30	20.8	419.8	5	0.0	0.0	0
31-40	0.0	0.0	0	4.0	0.0	1
41-50	6.4	13.8	5	5.0	2.0	3
51-60	19.0	251.3	6	9.0	8.0	3
61-70	14.0	0.0	1	4.0	0.0	1
71 AND >	11.0	0.0	1	14.0	16.0	2

ICDA CODE : 500

	MALE			FEMALE		
	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	2.0	0.0	15	2.0	0.0	13
6-20	4.9	13.0	95	2.3	1.3	81
21-30	8.4	3.4	39	2.6	3.0	22
31-40	8.5	0.6	6	2.4	0.6	5
41-50	2.0	0.0	1	2.0	0.0	1
51-60	0.0	0.0	0	0.0	0.0	0
61-70	0.0	0.0	0	0.0	0.0	0
71 AND >	0.0	0.0	0	0.0	0.0	0

ICDA CODE : 532

	MALE			FEMALE		
	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	0.0	0.0	0	0.0	0.0	0
6-20	71.0	1156.0	2	0.0	0.0	0
21-30	41.0	154.0	4	8.0	0.0	1
31-40	29.7	672.9	9	7.7	22.2	3
41-50	20.9	572.5	10	8.0	0.0	1
51-60	8.8	13.1	6	5.0	0.0	1
61-70	10.7	0.9	3	0.0	0.0	0
71 AND >	0.0	0.0	0	0.0	0.0	0

TABLE VI (continued)

ICDA CODE : 535

	MALE			FEMALE		
	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	0.0	0.0	0	1.0	0.0	1
6-20	7.7	64.9	3	3.0	0.0	1
21-30	16.6	357.7	7	0.0	0.0	0
31-40	29.5	877.3	4	0.0	0.0	0
41-50	4.5	12.3	2	1.8	0.7	4
51-60	4.2	11.8	5	3.0	0.0	1
61-70	5.8	28.7	4	4.0	0.0	1
71 AND >	0.0	0.0	0	0.0	0.0	0

ICDA CODE : 540

	MALE			FEMALE		
	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	8.0	12.7	3	0.0	0.0	0
6-20	10.0	82.5	33	6.2	17.6	14
21-30	10.8	31.2	23	3.2	0.2	5
31-40	21.0	169.0	2	3.5	0.3	2
41-50	14.0	76.5	4	7.0	4.7	3
51-60	0.0	0.0	0	4.0	0.0	1
61-70	7.0	0.0	1	5.0	0.7	3
71 AND >	0.0	0.0	0	0.0	0.0	0

ICDA CODE : 550

	MALE			FEMALE		
	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	1.8	0.1	20	0.0	0.0	0
6-20	5.9	17.0	42	2.5	0.3	2
21-30	13.5	207.6	41	4.0	0.0	1
31-40	13.4	65.9	27	4.0	0.0	2
41-50	6.9	17.9	38	4.7	1.6	3
51-60	6.2	20.5	33	0.0	0.0	0
61-70	6.3	13.1	17	5.0	0.0	1
71 AND >	9.2	13.8	5	0.0	0.0	0

ICDA CODE : 5749

	MALE			FEMALE		
	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	0.0	0.0	0	0.0	0.0	0
6-20	0.0	0.0	0	3.0	0.0	1
21-30	0.0	0.0	0	6.0	0.0	1
31-40	0.0	0.0	0	6.5	0.3	4
41-50	0.0	0.0	0	5.3	0.2	3
51-60	6.0	0.0	1	9.3	144.2	3
61-70	0.0	0.0	0	0.0	0.0	0
71 AND >	0.0	0.0	0	0.0	0.0	0

TABLE VI (continued)

ICDA CODE : 575

	MALE			FEMALE		
	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	0.0	0.0	0	0.0	0.0	0
6-20	0.0	0.0	0	4.5	2.3	2
21-30	17.0	0.0	1	3.8	3.9	15
31-40	8.0	1.0	4	4.9	1.6	7
41-50	5.7	13.6	3	4.6	10.8	7
51-60	9.6	27.8	5	6.4	9.6	9
61-70	0.0	0.0	0	0.0	0.0	0
71 AND >	6.5	6.3	2	0.0	0.0	0

ICDA CODE : 626

	MALE			FEMALE		
	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	0.0	0.0	0	0.0	0.0	0
6-20	0.0	0.0	0	2.3	0.9	9
21-30	0.0	0.0	0	6.7	257.7	45
31-40	0.0	0.0	0	3.2	5.4	56
41-50	0.0	0.0	0	2.8	4.0	86
51-60	0.0	0.0	0	2.3	1.6	58
61-70	0.0	0.0	0	2.0	0.2	12
71 AND >	0.0	0.0	0	2.0	0.0	1

ICDA CODE : 6409

	MALE			FEMALE		
	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	0.0	0.0	0	0.0	0.0	0
6-20	0.0	0.0	0	4.0	2.3	7
21-30	0.0	0.0	0	3.3	3.6	3
31-40	0.0	0.0	0	0.0	0.0	0
41-50	0.0	0.0	0	0.0	0.0	0
51-60	0.0	0.0	0	0.0	0.0	0
61-70	0.0	0.0	0	0.0	0.0	0
71 AND >	0.0	0.0	0	0.0	0.0	0

ICDA CODE : 725

	MALE			FEMALE		
	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	0.0	0.0	0	0.0	0.0	0
6-20	46.0	880.4	5	0.0	0.0	0
21-30	45.1	499.2	21	4.3	10.9	3
31-40	39.0	794.5	28	8.0	19.2	5
41-50	19.8	153.2	13	11.5	87.0	18
51-60	11.4	48.2	5	14.4	74.4	12
61-70	23.4	72.6	5	13.0	16.0	2
71 AND >	24.0	0.0	1	0.0	0.0	0

TABLE VI (continued)

ICDA CODE : 820

	MALE			FEMALE		
	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	0.0	0.0	0	0.0	0.0	0
6-20	64.0	1024.0	2	40.0	0.0	1
21-30	93.2	3119.0	5	0.0	0.0	0
31-40	0.0	0.0	0	0.0	0.0	0
41-50	38.0	0.0	1	0.0	0.0	0
51-60	104.0	0.0	1	9.8	36.2	4
61-70	0.0	0.0	0	17.0	0.0	1
71 AND >	19.0	0.0	1	18.0	19.0	4

disease/condition affecting a patient's length of stay. Any complications or additional diseases/conditions were not considered. To the extent that these secondary diseases/ conditions contributed, lengths of stay would be longer than those that would have resulted from only the main diagnosis. However, this factor was not considered by Joseph in the Iowa Hospitals. For this study it was assumed that the affect of secondary diseases/conditions was the same for the Oak Knoll and Iowa populations. Thus, these secondary diseases/ conditions have no affect on the comparative results.

Two of the mitigating factors mentioned have the effect of increasing lengths of stay in a military hospital. Thus, although it has not been proven that relative moral hazard does exist, this initial analysis of the military hospital, adjusted for characteristics which would not be present in a civilian prepaid faculity, does show that projections of great per capita jumps in the consumption of low-cost inpatient care may well have been exaggerated.

E. GENERAL UTILIZATION PATTERNS

From the data in Table I, the composition of the supported population was found to be 54% active duty personnel and dependents and 46% retired personnel and dependents. It was expected that this composition would be reflected in actual utilization of the hospital; however, such was not the case. From the data in Table VII it was found that of those persons actually using Oak Knoll during the period examined, 65% were active duty personnel and dependents

TABLE VII

LENGTH OF STAY; BY AGE, SEX, AND PATIENT CATEGORY

ACTIVE DUTY

	MALE			FEMALE		
AGE	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	0.0	0.0	0	0.0	0.0	0
6-20	24.2	861.6	1149	22.4	786.1	48
21-30	26.1	1060.5	1510	15.6	488.4	80
31-40	25.5	1103.1	574	18.4	585.2	10
41-50	27.6	1385.4	155	23.3	1555.2	12
51-60	21.4	1117.1	31	13.8	219.8	5
61-70	0.0	0.0	0	0.0	0.0	0
71 AND >	0.0	0.0	0	0.0	0.0	0

RETIRED

	MALE			FEMALE		
AGE	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	0.0	0.0	0	0.0	0.0	0
6-20	55.0	0.0	1	0.0	0.0	0
21-30	14.0	955.0	75	4.0	0.0	1
31-40	8.8	94.0	70	6.6	20.2	5
41-50	9.0	151.2	391	11.4	445.0	10
51-60	9.9	128.9	516	9.5	52.3	10
61-70	11.0	156.0	303	5.9	12.5	10
71 AND >	12.2	179.2	131	1.0	0.0	1

RESERVE

	MALE			FEMALE		
AGE	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	0.0	0.0	0	0.0	0.0	0
6-20	50.7	1461.6	3	0.0	0.0	0
21-30	107.0	10609.0	2	0.0	0.0	0
31-40	12.3	82.9	3	0.0	0.0	0
41-50	1.0	0.0	2	0.0	0.0	0
51-60	0.0	0.0	0	0.0	0.0	0
61-70	0.0	0.0	0	0.0	0.0	0
71 AND >	0.0	0.0	0	0.0	0.0	0

DEPENDENT, ACTIVE DUTY

	MALE			FEMALE		
AGE	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	4.2	21.1	831	4.5	61.0	777
6-20	3.8	20.3	258	4.2	31.5	592
21-30	10.8	291.8	6	4.5	31.7	1113
31-40	3.0	1.0	2	5.2	35.1	438
41-50	0.0	0.0	0	6.1	70.5	111
51-60	0.0	0.0	0	7.0	42.7	29
61-70	30.4	490.6	5	21.8	420.2	12
71 AND >	0.0	0.0	0	10.8	30.6	9

DEPENDENT, RETIRED

	MALE			FEMALE		
AGE	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	3.9	18.8	65	2.9	2.9	20
6-20	6.3	81.8	323	5.1	244.3	317
21-30	11.0	369.9	22	4.7	24.7	116
31-40	4.4	4.2	10	6.3	41.0	174
41-50	10.3	42.9	3	7.8	123.5	568
51-60	5.2	8.6	5	8.4	118.6	454
61-70	6.2	14.5	6	8.6	88.2	210
71 AND >	0.0	0.0	0	10.4	108.6	122

ALL OTHERS

	MALE			FEMALE		
AGE	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	1.5	0.3	4	6.0	1.0	2
6-20	7.6	53.8	5	9.7	196.6	6
21-30	15.3	323.3	18	5.7	25.7	11
31-40	11.6	50.2	7	0.0	0.0	1
41-50	14.7	361.9	6	3.0	0.0	1
51-60	23.1	1005.6	8	26.0	0.0	1
61-70	2.0	0.0	1	0.0	0.0	0
71 AND >	0.0	0.0	0	0.0	0.0	0

and 34% retired personnel and dependents. The reason for this difference is probably the CHAMPUS program.

CHAMPUS is the Civilian Health and Medical Program for the Uniformed Services. It is a government sponsored and partially financed health care program available to active duty and retired military personnel and their dependents. However, eligibility for use of the program is restricted. Essentially active duty personnel and dependents are not eligible unless specifically authorized by local medical officials or in an emergency situation. Retired personnel and their dependents, however, have free choice between CHAMPUS and military care. Except for a small copayment by a retired person or his dependents, CHAMPUS costs the individual no more than military care. Thus it appears that retired personnel and their dependents, to some extent, prefer civilian care under CHAMPUS to military care.

Upon completion of the comparisons of Oak Knoll data with that from the Iowa Hospitals, it was noted that only 1,614 of the 11,779 patients served by Oak Knoll during the period examined were represented in the data. Thus, it was decided to examine the distribution of admissions in each ICDA category. This grouping was chosen since the ICDA coding system groups diseases/conditions into similiar types and, thus, similiar treatments. Table VIII lists the ICDA code groups and their medical description. Table IX lists the number of admissions to Oak Knoll from June 1972 to May 1973 for each group.

TABLE VIII

ICDA CODE GROUPS DESCRIPTIONS

ICDA CODE GROUP	DESCRIPTION
000-136	Infective and parasitic diseases
140-239	Neoplasms
240-279	Endocrine, nutritional and metabolic diseases
280-289	Diseases of the blood and blood-forming organs
290-315	Mental disorders
320-389	Diseases of the nervous system and sense organs
390-458	Diseases of the circulatory system
460-519	Diseases of the respiratory system
520-577	Diseases of the digestive system
580-629	Diseases of the genitournary system
630-678	Complications of pregnancy, childbirth, and the puerperium
680-686	Diseases of the skin and subcutaneous tissue
710-738	Diseases of the musculosketetal system and connective tissue
740-759	Congenital anomalies
760-779	Certain cases of perinatal morbidity and mortality
780-796	Symptoms and ill-defined conditions

TABLE IX

NUMBER OF ADMISSIONS IN EACH ICDA GROUP

ICDA CODE GROUP	NUMBER OF ADMISSIONS
000 -- 136	361
140 -- 239	769
240 -- 279	207
280 -- 289	75
290 -- 315	959
320 -- 389	608
390 -- 458	645
460 -- 519	928
520 -- 577	1057
580 -- 629	913
630 -- 678	1213
680 -- 709	380
710 -- 738	644
740 -- 759	200
760 -- 779	16
780 -- 796	414
800 -- 999	1143

The data in Table IX accounts for 10,538 of 11,779 admissions to Oak Knoll during the period examined. The remaining 1247 admissions were under the ICDA code group Y000-Y030 which is for special conditions and examinations without sickness and classification of infants according to type of birth.

Use of the information provided by Table IX will enable an analyst to determine those areas of treatment that have the largest number of occurances. However, even with this knowledge, no comparative analysis can be done without comparable data from civilian hospitals. It was this lack of data from the civilian community that precluded further examination of the code groups with a large number of occurances.

F. OTHER STATISTICS AND RATES

Table X through XIV are a collection of basic data that are generally spoken to in health care literature. Though not of immediate use in the present study, they were felt to be of interest in providing a basis from which a general idea of the magnitude of operations at Oak Knoll can be determined. The following tables are included:

TABLE NUMBER	DESCRIPTION
X	Admission rates per 1000 eligibles by age and sex
XI	Admission rates per 1000 eligibles by age, sex and ICDA code

TABLE X

ADMISSION RATES: BY AGE AND SEX

AGE	MALE RATE/1000	FEMALE RATE/1000
0-5	4.821	4.280
6-20	9.316	5.159
21-30	8.748	7.077
31-40	3.568	3.364
41-50	2.984	3.761
51-60	3.000	2.673
61-70	1.693	1.243
71 AND >	0.707	0.707

TABLE XI

ADMISSION RATES

BY AGE, SEX AND ICDA CODE

ICDA CODE : 0092

AGE	MALE RATE/1000	FEMALE RATE/1000
0-5	0.064	0.027
6-20	0.129	0.070
21-30	0.086	0.037
31-40	0.011	0.011
41-50	0.021	0.011
51-60	0.011	0.016
61-70	0.0	0.0
71 AND >	0.005	0.011

ICDA CODE : 250

AGE	MALE RATE/1000	FEMALE RATE/1000
0-5	0.0	0.005
6-20	0.032	0.032
21-30	0.027	0.059
31-40	0.064	0.037
41-50	0.027	0.037
51-60	0.021	0.037
61-70	0.027	0.016
71 AND >	0.021	0.011

ICDA CODE : 427

AGE	MALE RATE/1000	FEMALE RATE/1000
0-5	0.0	0.0
6-20	0.016	0.0
21-30	0.032	0.005
31-40	0.027	0.016
41-50	0.048	0.021
51-60	0.070	0.032
61-70	0.043	0.037
71 AND >	0.037	0.043

ICDA CODE : 431

AGE	MALE RATE/1000	FEMALE RATE/1000
0-5	0.0	0.0
6-20	0.0	0.0
21-30	0.0	0.0
31-40	0.0	0.0
41-50	0.0	0.0
51-60	0.0	0.0
61-70	0.0	0.0
71 AND >	0.0	0.005

TABLE XI (continued)

ICDA CODE : 440

AGE	MALE RATE/1000	FEMALE RATE/1000
0-5	0.0	0.0
6-20	0.0	0.0
21-30	0.0	0.0
31-40	0.005	0.0
41-50	0.011	0.0
51-60	0.070	0.011
61-70	0.011	0.005
71 AND >	0.0	0.0

ICDA CODE : 455

AGE	MALE RATE/1000	FEMALE RATE/1000
0-5	0.0	0.0
6-20	0.005	0.005
21-30	0.032	0.005
31-40	0.086	0.043
41-50	0.070	0.048
51-60	0.016	0.021
61-70	0.011	0.005
71 AND >	0.011	0.005

ICDA CODE : 466

AGE	MALE RATE/1000	FEMALE RATE/1000
0-5	0.096	0.021
6-20	0.0	0.0
21-30	0.005	0.005
31-40	0.0	0.011
41-50	0.005	0.0
51-60	0.005	0.005
61-70	0.0	0.005
71 AND >	0.0	0.005

ICDA CODE : 470

AGE	MALE RATE/1000	FEMALE RATE/1000
0-5	0.0	0.0
6-20	0.0	0.0
21-30	0.0	0.011
31-40	0.0	0.0
41-50	0.0	0.0
51-60	0.0	0.0
61-70	0.0	0.005
71 AND >	0.0	0.0

TABLE XI (continued)

ICDA CODE : 485

AGE	MALE RATE/1000	FEMALE RATE/1000
0-5	0.021	0.0
6-20	0.0	0.0
21-30	0.005	0.0
31-40	0.0	0.0
41-50	0.0	0.0
51-60	0.0	0.0
61-70	0.0	0.0
71 AND >	0.0	0.0

ICDA CODE : 486

AGE	MALE RATE/1000	FEMALE RATE/1000
0-5	0.054	0.059
6-20	0.037	0.016
21-30	0.027	0.0
31-40	0.0	0.005
41-50	0.027	0.016
51-60	0.032	0.016
61-70	0.005	0.005
71 AND >	0.005	0.011

ICDA CODE : 500

AGE	MALE RATE/1000	FEMALE RATE/1000
0-5	0.080	0.070
6-20	0.509	0.434
21-30	0.209	0.118
31-40	0.032	0.027
41-50	0.005	0.005
51-60	0.0	0.0
61-70	0.0	0.0
71 AND >	0.0	0.0

ICDA CODE : 532

AGE	MALE RATE/1000	FEMALE RATE/1000
0-5	0.0	0.0
6-20	0.011	0.0
21-30	0.021	0.005
31-40	0.048	0.016
41-50	0.054	0.005
51-60	0.032	0.005
61-70	0.016	0.0
71 AND >	0.0	0.0

TABLE XI (continued)

ICDA CODE : 535

AGE	MALE RATE/1000	FEMALE RATE/1000
0-5	0.0	0.005
6-20	0.016	0.005
21-30	0.037	0.0
31-40	0.021	0.0
41-50	0.011	0.021
51-60	0.027	0.005
61-70	0.021	0.005
71 AND >	0.0	0.0

ICDA CODE : 540

AGE	MALE RATE/1000	FEMALE RATE/1000
0-5	0.016	0.0
6-20	0.177	0.075
21-30	0.123	0.027
31-40	0.011	0.011
41-50	0.021	0.016
51-60	0.0	0.005
61-70	0.005	0.016
71 AND >	0.0	0.0

ICDA CODE : 550

AGE	MALE RATE/1000	FEMALE RATE/1000
0-5	0.107	0.0
6-20	0.225	0.011
21-30	0.220	0.005
31-40	0.145	0.011
41-50	0.204	0.016
51-60	0.177	0.0
61-70	0.091	0.005
71 AND >	0.027	0.0

ICDA CODE : 5749

AGE	MALE RATE/1000	FEMALE RATE/1000
0-5	0.0	0.0
6-20	0.0	0.005
21-30	0.0	0.005
31-40	0.0	0.021
41-50	0.0	0.016
51-60	0.005	0.048
61-70	0.0	0.0
71 AND >	0.0	0.0

TABLE XI (continued)

ICDA CODE : 575

AGE	MALE RATE/1000	FEMALE RATE/1000
0-5	0.0	0.0
6-20	0.0	0.011
21-30	0.005	0.080
31-40	0.021	0.037
41-50	0.016	0.037
51-60	0.027	0.048
61-70	0.0	0.0
71 AND >	0.011	0.0

ICDA CODE : 626

AGE	MALE RATE/1000	FEMALE RATE/1000
0-5	0.0	0.0
6-20	0.0	0.048
21-30	0.0	0.241
31-40	0.0	0.300
41-50	0.0	0.461
51-60	0.0	0.311
61-70	0.0	0.064
71 AND >	0.0	0.005

ICDA CODE : 6409

AGE	MALE RATE/1000	FEMALE RATE/1000
0-5	0.0	0.0
6-20	0.0	0.037
21-30	0.0	0.016
31-40	0.0	0.0
41-50	0.0	0.0
51-60	0.0	0.0
61-70	0.0	0.0
71 AND >	0.0	0.0

ICDA CODE : 725

AGE	MALE RATE/1000	FEMALE RATE/1000
0-5	0.0	0.0
6-20	0.027	0.0
21-30	0.112	0.016
31-40	0.150	0.027
41-50	0.070	0.096
51-60	0.027	0.064
61-70	0.027	0.011
71 AND >	0.005	0.0

TABLE XI (continued)

ICDA CODE : 820

AGE	MALE RATE/1000	FEMALE RATE/1000
0-5	0.0	0.0
6-20	0.011	0.005
21-30	0.027	0.0
31-40	0.0	0.0
41-50	0.005	0.0
51-60	0.005	0.021
61-70	0.0	0.005
71 AND >	0.005	0.021

TABLE XII

SURGICAL RATES: BY AGE AND SEX

AGE	MALE RATE/1000	FEMALE RATE/1000
0-5	0.900	0.787
6-20	4.168	3.739
21-30	3.975	5.486
31-40	1.655	2.571
41-50	1.709	2.662
51-60	1.580	1.773
61-70	1.002	0.691
71 AND >	0.354	0.230

TABLE XIII

LENGTH OF STAY: BY AGE AND SEX

	MALE			FEMALE		
AGE	MEAN	VARIANCE	NUMBER	MEAN	VARIANCE	NUMBER
0-5	4.1	20.9	900	4.5	59.5	799
6-20	17.8	673.8	1739	5.4	155.6	963
21-30	25.3	1066.4	1633	5.2	65.6	1321
31-40	23.2	996.4	666	5.7	48.3	628
41-50	14.2	565.6	557	7.8	148.8	702
51-60	10.7	204.5	560	8.5	114.7	499
61-70	11.1	166.4	316	9.2	111.0	232
71 AND >	12.1	179.2	132	10.4	103.1	132

TABLE XIV

PATIENT DAYS PER 1000 ELIGIBLES
BY AGE AND SEX

AGE	MALE	FEMALE
0-5	19.92	19.26
6-20	166.26	28.09
21-30	221.35	36.62
31-40	82.63	19.10
41-50	42.36	29.40
51-60	32.06	22.64
61-70	18.80	11.44
71 AND >	8.56	7.35

APPENDIX A

SAMPLE SIZE CALCULATIONS

A. AGE DISTRIBUTION OF RETIRED PERSONNEL

To calculate the sample size necessary to predict the proportion of retired personnel falling in a particular age group, a slightly different interval than that given before was used. Miller [Ref. 6] states that the simultaneous confidence intervals for the proportion of personnel falling in category j, p_j, is given by

$$\hat{p}_j \pm \left[X^2_{m-1}(\alpha)\right]^{\frac{1}{2}} \left[\frac{\hat{p}_j(1-\hat{p}_j)}{n}\right]^{\frac{1}{2}} \qquad j = 1, 2, \ldots, m$$

In order to obtain an estimate of n from this interval it was required that:

$$|p_j - \hat{p}_j| \leq 0.03$$

or

$$\left[X^2_{m-1}(\alpha)\right]^{\frac{1}{2}} \left[\frac{\hat{p}_j(1-\hat{p}_j)}{n}\right]^{\frac{1}{2}} \leq 0.03 \qquad (1)$$

It is clear from this formulation that the maximum sample size would occur when $\hat{p}_j = 0.25$. In order to keep sample sizes to a more manageable number a better estimate was used of the maximum $\hat{p}_j$ to be expected. From the United States Bureau of Census information on the 1970 census it was found that the maximum proportion in 10 year groups of approximately the same age as desired in this study was 0.28 for California.

This proportion was used to calculate the required sample size. Substituting m=5 (5 groups, 10 years each) $\alpha = 0.05$ and $\hat{p}_j = 0.28$, into equation (1) the required sample size is 2126. Thus, with a simple random sample of size 2126, the proportion of persons falling in each age group would be known within .03 with a 95% confidence.

B. MEAN NUMBER OF DEPENDENTS PER RETIRED MILITARY

In determining the number of dependents per retired military person, a dependent was defined to be the member's spouse or any children still residing in the retired person's home. This definition was chosen since children are no longer eligible for military health care, based on their parents service, after they reach the age of 18 unless they are in college or non-self supporting.

The mean number of dependents per retired military was determined through surveys conducted at Navy Exchanges in the Oak Knoll area. A two-step sampling procedure was followed as discussed in Cochran [Ref. 8]. The initial sample was used to obtain an estimate for the population variance.

Assuming the estimator for the mean number of dependents is normally distributed, Cochran [Ref. 8] gives the following formula for the total sample size (including the initial sample):

$$n = \frac{S_1^2}{V}\left(1 + \frac{2}{n_1}\right)$$

where: S_1^2 = estimate of the population variance obtained from the initial sample

n_1 = initial sample size

V = d^2/t^2 = variance of the estimator

d = chosen margin of error

t = abscissa of the normal curve that cuts off an area α at the tails

For estimating the mean number of dependents, the following values were chosen:

n_1 = 500

d = .1

t = 2.33

thus a 95% confidence interval of width .2 about the estimated mean. This interval was chosen since it was expected that the mean would be near 2.0. With these numbers we would be 95% confident we were within 10% of the actual mean value. From the initial survey S_1^2 was calculated to be 1.760. Inserting S_1^2, n_1, d and t into the formula for the final sample size produces a required sample size of 956.

C. PROPORTIONS

Two proportions were necessary to fully estimate the total number of retired military personnel living in the Oak Knoll area. These proportions were the number of retired personnel that have their retirement-pay check sent to a bank not in the Oak Knoll area and the proportion of retired military personnel who have waived military pay. Estimations

of these two quantities was done using the two sample technique described in Cochran [Ref. 8].

Using the two-sample technique for proportions, the initial sample was used to obtain as estimate of the proportions desired to use in calculating the total sample size required. Cochran [Ref. 8] states that in order to obtain an estimate of the proportion desired the final sample size is given by:

$$n = \frac{p_1 q_1}{V} + \frac{3 - 8p_1 q_1}{p_1 q_1} + \frac{1 - 3p_1 q_1}{Vn_1}$$

where: p_1 = estimate of the proportion from the initial sample

$q_1 = 1 - p_1$

n_1 = size of the initial sample

V = the desired variance of the estimator for the proportion

The initial sample size was 508. The variance of the estimator, V, was chosen as 0.0001 for both proportions. Estimates of the proportions made from the initial sample were $p_1 = 0.0903$ for the proportion of retirees who have their retired pay check sent to an area outside the Oak Knoll area and $p_2 = 0.0197$ for the proportion of retirees who have waived retired pay. Using these results the required total sample sizes were 856 for p_1 and 360 for p_2.

With this method of estimation, the ordinary binomial estimates, p_1 and p_2, made from the complete sample of size

n is slightly biased. To correct for bias, the estimate for p_1 and p_2 was taken as:

$$p_i = p_i + \frac{V(1-2p)}{p_i q_i} \qquad i = 1,2$$

According to Cochran [Ref. 8], the number of observed persons falling in the category for which this sample was made is too small to use a normal approximation in computing the confidence intervals. Confidence limits must be calculated from the binomial tables and adjustments made using a finite population correction. In the two cases considered here, the finite population correction was negligible. Thus the confidence limits were read directly from charts of confidence intervals for proportions found in the <u>Handbook of Tables for Probability and Statistics</u> [Ref. 9] after the sample was taken and the proportions calculated.

LIST OF REFERENCES

1. Joseph, Hyman, "Hospital Insurance and Moral Hazard", The Journal of Human Resources, Vol. VII, No. 2, p. 152-161, Spring, 1972.

2. Naval Facilities Command Publication P-80, Facility Planning Factors for Naval Shore Activities (U), January 1967.

3. Department of the Navy Publication NAVSO P-1385, Distribution of Manpower in the United States (U), p. 7-21, 2 October 1972.

4. Chief of Naval Operations Notice 05400, "Naval Aeronautical Organization, CONFIDENTIAL, 1972.

5. Department of Defense, "Selected Manpower Statistics", p. P25.1, P25.3, P25.6, P26.0, June 1973.

6. Miller, R. G., Jr., Simultaneous Statistical Inference, p. 215-218, McGraw-Hill, 1966.

7. Walsh, D. F., Effects on Utilization of Essentially Costless Medical Care, Master's Degree Thesis, Naval Postgraduate School, Monterey, California, 1973.

8. Cochran, William G., Sampling Techniques, p. 77-78, 1963.

9. Beyer, William H., Handbook of Tables for Probability and Statistics, p. 219.

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The present study proposes the use of the time a patient spends in a military hospital as a measure of the efficiency of that military hospital through comparison with lengths of stay in a civilian hospital. The same comparison is proposed as an indicator of how utilization patterns in the general populace may change if large-scale access to comprehensive prepaid health care is implemented. In addition an algorithm for determing the size

of the population supported by a military hospital is developed.

The study concludes that length of stay can be used as a measure of hospital efficiency. However, the results of a comparison with civilian hospital lengths of stay must be tempered by consideration of the uniqueness of the military population served. It is also concluded that the probable degree of increased utilization of inpatient care resulting from large scale access to low-cost health care is very small or even negative.